Dr Prashant Kumar 22/11/2023 (13) (12)

National Institute of Technology Hamirpur (HP)

B. Tech. End Semester Examination' November 2023

Branch: Mechanical Engineering — Semester: 5th
Course Name: Thermal Power Engineering-I — Course Code: ME 313
Time: 3.0 Hrs. — Maximum Marks: 50

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1. "Carnot Engine gives the maximum possible thermal efficiency which can be obtained for the given temperature limits. However, it is a hypothetical device and is not possible to devise it." Explain. (5)
2. Derive an expression for maximum blade efficiency for a reaction turbine in terms of blade speed ratio. (10)
3. In a Parson reaction turbine, the angles of receiving tips are 35° and of discharging tips, 20°. The blade speed is 100 m/s. Calculate the tangential force, power developed, diagram efficiency, and axial thrust of the turbine, if its steam consumption is 1 kg/min. (5)
4. Prove that the stagnation temperature and stagnation pressure remain constant for an isentropic flow through the nozzle. (5)
5. Prove that for an isentropic flow between two states 1 and 2 through a duct,

$$\frac{T_2}{T_1} = \frac{1 + \frac{\gamma - 1}{2} M_2^2}{1 + \frac{\gamma - 1}{2} M_1^2}$$

(5)

6. Static air at 10 bar and 800°C flows through a duct. Calculate the temperature, velocity and Mach number at point where pressure is 5 bar. Assume the flow to be isentropic. Given c_p = 1.005 kJ/kg-K and γ = 1.4 for air. (5)
7. Prove that for the chocked flow, M = 1 and A = A*, the maximum flow rate of air through the nozzle is

$$\dot{m}_{max} = \frac{0.685 P_0 A^*}{\sqrt{RT_0}}$$

where P_0 and T_0 is the stagnation pressure and stagnation temperature of air, and R is gas constant. (10)

8. Air at 8.6 bar and 190°C expands at a rate of 4.5 kg/s through a convergent-divergent nozzle to an atmospheric pressure of 1.013 bar. Assuming the inlet velocity is negligible, calculate throat and exit cross-sectional areas of the nozzle. (5)